

## 1.0 Introduction

This section presents the calculation of risk-based preliminary remediation goals (PRGs) in sediment and biota. Risk-based PRGs were calculated for all contaminants that posed an excess lifetime cancer risk greater than  $1 \times 10^{-6}$  or a hazard quotient greater than 1 in the final Portland Harbor Baseline Human Health Risk Assessment (Kennedy-Jenks 2013) assuming reasonable maximum exposure. For cancer effects, risk-based PRGs were calculated as the concentration consistent with a specified target excess cancer risk (TR) of  $1 \times 10^{-6}$ . For non-cancer effects, the risk-based PRGs were the calculated concentration that would result in a specified target hazard quotient (THQ) of 1. In the case of both cancer and non-cancer effects, the PRGs are calculated based on specified exposure pathways and receptors.

**Commented [BLJ1]:** I think this needs a little more introductory information. This text is a suggestion. Use this or modify if not strictly accurate.

## 1.1 Risk-Based PRGs for Fish/Shellfish Tissue

Risk-based preliminary remediation goals (PRGs) are calculated for fish/shellfish tissue and for sediment. Tissue concentrations were calculated as they represent a direct exposure point for human receptors, and because target tissue concentrations are needed to derive sediment concentrations using either sediment-tissue relationships – as either a biota-sediment accumulation regression relationship (BSAR) or biota-sediment accumulation factor (BSAF), or the Arnot and Gobas Food Web Model as refined for Portland Harbor (Windward, 2009).

**Commented [BLJ2]:** The title refers to shellfish, but the following text seems to exclusively deal with fish. Please add text to explain why shellfish were not considered to be an exposure pathway (if that is in fact the case).

### 1.1.1 Risk-Based Tissue PRGs for Direct Consumption

Risk-based tissue PRGs associated with consumption of fish and shellfish were calculated for resident fish using the following equations, adapted from Section 3.5.5 of the Final BHHRA (Kennedy/Jenks, 2013):

Non-cancer effects:

$$PRG_{tissue} = \frac{THQ \times BW \times AT}{ED \times EF \times \frac{1}{RfD} \times CR \times 0.001 \text{ kg/g}} \quad (1)$$
$$PRG_{tissue,age} = \frac{THQ \times BW_{age} \times AT}{ED_{age} \times EF \times \frac{1}{RfD} \times CR_{age} \times 0.001 \text{ kg/g}}$$

**Commented [BLJ3]:** The use of CR with no subscript can be confusing. It's defined in Table 2 as maternal consumption rate of fish. Perhaps you need to add a subscript.

**Commented [BLJ4]:** There is no AT value specified in Table 2 for non-cancer effects.

**Commented [BLJ5]:** Any subsequent discussions of this document would be facilitated by numbering the equations. I suggest that be done.

**Commented [BLJ6]:** This is a suggested change to notation to account for age, where age can have values of "a" or "c". Otherwise you're left with generic terms like BW, ED, and CR to which there is no numeric value in Table 2. This modification, if adopted, would need to be introduced throughout the Appendix.

**Field Code Changed**

**Commented [BLJ7]:** I presume the "nc" subscript on AT refers to non-cancer. Since this is a PRG for carcinogenic effects is this an error? The value of AT\_nc is not specified in Table 2.

**Formatted:** Body Text, Centered, Indent: Left: 0"

**Commented [BLJ8]:** Not clear to me when the adjusted CR value would be used versus the child- or adult-related values. Needs some additional explanatory text.

**Commented [BLJ9]:** This sentence says that the "exposure was evaluated." That's incorrect. It's the PRG value that's being evaluated.

Carcinogenic effects:

$$PRG_{tissue} = \frac{TR \times BW_c \times AT_{nc}}{ED \times EF \times CSF \times CR \times 0.001 \text{ kg/g}}$$

PRG values were also calculated for Combined child and adult exposure was evaluated consistent with the following equations:

$$PRG_{tissue} = \frac{TR \times AT}{EF \times CR_{adj} \times CSF \times 0.001 \text{ kg / g}}$$

$$PRG_{tissue} = \frac{TR \times AT}{EF \times CR_{f-adj} \times CSF \times 0.001 \text{ kg / g}}$$

**Commented [BLJ10]:** No definition provided for CR\_adj. I presume that it is the same as CR\_f\_adj. If so, change in equation or list of defined terms to make consistent.

**Field Code Changed**

where:

$$CR_{f-adj} = \frac{ED_c \times CR_c}{BW_c} + \frac{ED_a \times CR_a}{BW_a}$$

and:

PRG<sub>tissue</sub> = risk-based concentration in fish/shellfish tissue (µg/kg, wet-weight)  
 CR<sub>c</sub> = consumption rate of fish/shellfish – child (g/day, wet-weight)  
 CR<sub>a</sub> = consumption rate of fish/shellfish – adult (g/day, wet-weight)  
 CR<sub>f-adj</sub> = consumption rate of fish/shellfish – age adjusted (g/day – wet weight)  
 EF = exposure frequency (days/year)  
 ED<sub>c</sub> = exposure duration – child (years)  
 ED<sub>a</sub> = exposure duration – adult (years)  
 BW<sub>c</sub> = body weight – child (kg)  
 BW<sub>a</sub> = body weight – adult (kg)  
 AT = averaging time (days)  
 CSF = cancer slope factor (mg/kg-day)<sup>-1</sup>  
 RfD = reference dose (mg/kg-day)  
 THQ = target hazard quotient  
 TR = target excess cancer risk

The exposure assumptions used to estimate exposure from fish and shellfish consumption are presented in Table 2. Reference doses are .... The value of the reference doses used in the risk-based PRG calculations are contained in Table xxx of xxxxx.

**Commented [BLJ11]:** Reference doses are not included in Table 2. Need some explanation of what they are and where the values used in the PRG calculations can be found.

### 1.1.2 Risk-Based Tissue PRGs due to Infant Consumption of Breast Milk

Risk-based PRGs in fish and shellfish tissue were calculated using the following equation adapted from Section 3.5.6 of the Final Portland Harbor BHHRA and The equation presumes using a steady-state model of maternal fish consumption that assumes that maternal intake occurs over a period greater than the biological half-life of the contaminant in the body:

**Commented [BLJ12]:** Meaning initially unclear. Make sure that suggested changes are correct.

$$PRG_{tissue} (\mu\text{g/kg}) = \frac{\left( \frac{THQ \times BW_{inf} \times AT_{inf} \times RfD}{f_{mbm} \times CR_{milk} \times ED_{inf}} \right) \times [\ln(2) \times f_{fm}] \times BW_a \times AT_m}{(h \times f_f) \times EF_a \times ED_a \times 10^{-3} \text{ kg / g} \times 10^{-3} \text{ mg / } \mu\text{g} \times AE \times CR_{fish}}$$

where:

PRG <sub>tissue</sub>	= risk-based PRG in fish/shellfish (µg/kg – wet weight)
THQ	= target hazard quotient
RfD	= reference dose (mg/kg-day)
AE	= oral absorption efficiency of the chemical (unitless)
h	= biological half-life of chemical in the body BS (days)
f <sub>f</sub>	= fraction of absorbed chemical stored in fat
f <sub>fm</sub>	= fraction of mother's weight that is fat
f <sub>mbm</sub>	= fraction of fat in breast milk
CR <sub>milk</sub>	= infant consumption rate of breast milk (kg/day)
CR	= maternal consumption rate of fish (g/day)
ED <sub>inf</sub>	= exposure duration of breastfeeding infant (days)
EF <sub>a</sub>	= exposure frequency – adult (maternal exposure, days/yr)
ED <sub>a</sub>	= exposure duration – adult (daysyears)
BW <sub>inf</sub>	= average infant body weight (kg)
BW <sub>a</sub>	= body weight – adult (maternal body weight, kg)
AT <sub>inf</sub>	= averaging time – infant exposure (days)
AT <sub>m</sub>	= averaging time – maternal exposure (days)

**Commented [BLJ13]:** Definition from Table 2

**Commented [BLJ14]:** Added units. Please check that this is correct

**Commented [BLJ15]:** What does “BS” mean in this definition?

**Commented [BLJ16]:** Is the same as CR<sub>fish</sub> in previous equation? Please modify notation as necessary to make consistent.

**Commented [BLJ17]:** These units can't be correct since this is the only parameter defined with a time-scale of years and the result is a mass concentration. My guess would be that the exposure duration must be in years. Please confirm that calculations were carried out correctly.

**Commented [BLJ18]:** Please check that this is right and check that calculations have been done correctly.

**Commented [BLJ19]:** No value given for AT<sub>m</sub> in Table 2.

### 1.1.3 Incidental Ingestion of Sediment

Risk-based PRGs associated with the incidental ingestion of sediment were calculated using the following equations adapted from Section 3.5.1 of the Final BHHRA:

Noncancer effects:

$$Conc_{sed} = \frac{THQ \times BW \times AT}{EF \times ED \times \frac{1}{RfD} \times IRS \times 10^{-6} \text{ kg / mg}}$$

**Commented [BLJ20]:** Is there some reason this is denoted Conc<sub>sed</sub> rather PRG<sub>sed</sub>. Seems to be inconsistent.

$$PRG_{sed} = \frac{THQ \times BW \times AT}{EF \times ED \times \frac{1}{RfD} \times IRS \times 10^{-6} \text{ kg / mg}}$$

**Commented [BLJ21]:** As mentioned above, there is no AT value specified for non-cancer effects in Table 2.

**Field Code Changed**

Carcinogenic effects:

$$PRG_{sed} = \frac{TR \times BW \times AT}{EF \times ED \times CSF \times IRS \times 10^{-6} \text{ kg / mg}}$$

**Commented [BLJ22]:** Is there some reason this doesn't have a “c” subscript on “AT”, similar to the AT term in the next equation?

Risk-based PRGs based on carcinogenic effects, and where exposure was assumed to occur from childhood through adult years were age-weighted using the following equation:

$$PRG_{sed} = \frac{TR \times AT_c}{CSF \times EF \times IFS_{adj} \times 10^{-6} \text{ kg / mg}}$$

Where the averaging time  $AT_c$  is...

$$IFS_{adj} = \frac{ED_c \times IRS_c}{BW_c} + \frac{ED_a \times IRS_a}{BW_a}$$

**Commented [BLJ23]:**  $AT_c$  term not defined in list of parameters. Need to explain why it's used here and AT is used in prior.

and:

- $PRG_{sed}$  = risk-based PRG in soil or sediment (~~ug/kg or~~ mg/kg)
- $IFS_{adj}$  = age-adjusted soil/sediment incidental ingestion factor [(mg-year)/(kg-day)]
- $IRS_a$  = incidental sediment ingestion rate-adults (mg/day)
- $IRS_c$  = incidental sediment ingestion rate-children (mg/day)
- $EF$  = exposure frequency (days/year)
- $ED_a$  = exposure duration – adult (years)
- $ED_c$  = exposure duration – child (years)
- $BW_a$  = body weight – adult (kg)
- $BW_c$  = body weight – child (kg)
- $AT$  = averaging time (days)
- $THQ$  = target hazard quotient
- $TR$  = target excess cancer risk
- $CSF$  = cancer slope factor (mg/kg-day)<sup>-1</sup>

**Commented [BLJ24]:** Based on my check of parameter dimensions this must be mg/kg.

The following equation was used to calculate risk-based PRGs in sediment for contaminants known to be mutagenic (cPAHs), and incorporates the potency adjustments of 10 and 3, respectively, for exposures occurring before 2 years of age and from ages 2 through 16:

$$PRG_{sed} = \frac{TR \times AT}{EF \times CSF \times ISIFM_{adj} \times 10^{-6} \text{ kg / mg}}$$

$$ISIFM_{adj} = \left( \frac{(ED_{0-2} \times IRS_c) \times 10}{BW_c} + \frac{(ED_{2-6} \times IRS_c) \times 3}{BW_c} + \frac{(ED_{6-16} \times IRS_a) \times 3}{BW_a} + \frac{(ED_{16-30} \times IRS_a) \times 1}{BW_a} \right)$$

where:

$PRG_{sed}$  = chemical concentration in soil or sediment (mg/kg)  
 $IRS_a$  = adult soil/sediment ingestion rate (mg/day)  
 $IRS_c$  = child soil/sediment ingestion rate (mg/day)  
 $ISIFM_{adj}$  = incidental sediment ingestion factor for mutagens (mg-yr/kg-day)  
 $EF$  = exposure frequency (days/year)  
 $ED_{0-2}$  = exposure duration ages 0-2 (years)  
 $ED_{2-6}$  = exposure duration ages 2-6 (years)  
 $ED_{6-16}$  = exposure duration ages 6-16 (years)  
 $ED_{16-30}$  = exposure duration ages 16-30 (years)  
 $BW_a$  = adult body weight (kg)  
 $BW_c$  = child body weight (kg)  
 $AT$  = averaging time (days)  
 $CSF$  = cancer slope factor (mg/kg-day)<sup>-1</sup>  
 $RfD$  = reference dose (mg/kg-day)  
 $THQ$  = target hazard quotient  
 $TR$  = target excess cancer risk

**Commented [BLJ25]:** Meaning of this term is not clear.

Also, value not in Table 2. I also was unable to find where within the BHHRA the values were noted or a discussion as to how they were obtained.

**Commented [BLJ26]:** Should there be an infant body weight as well for ages 0 to 2?

The exposure assumptions are provided in Table 2.

#### 1.1.4 Dermal Contact with Sediment

Risk-based PRGs for dermal contact with sediment were calculated using the following equations adapted from Section 3.5.2 of the Final BHHRA:

Non-cancer effects:

$$PRG_{sed} = \frac{THQ \times AT \times BW}{EF \times ED \times \frac{1}{RfD} \times SA \times AF \times ABS \times 10^{-6} \text{ kg / mg}}$$

**Commented [BLJ27]:** Same comment as above on use of "AT" for non-cancer effect and notation that neglects subscript indicating age on BW, SA, ED, and AF.

Cancer effects:

$$PRG_{sed} = \frac{TR \times AT_c \times BW}{EF \times ED \times CSF \times SA \times AF \times ABS \times 10^{-6} \text{ kg / mg}}$$

Combined child and adult age-weighted exposures resulting from dermal contact with contaminants in sediment for the recreational beach user exposure scenarios were calculated consistent with the following equations:

$$PRG_{sed} = \frac{TR \times AT_c}{CSF \times EF \times ISF_{adj} \times 10^{-6} \text{ kg / mg}}$$

where:

$$DFS_{adj} = \frac{ED_c \times EF_c \times AF_c \times SA_c}{BW_c} + \frac{ED_a \times EF_a \times AF_a \times SA_a}{BW_a}$$

and:

$PRG_{sed}$	=	concentration in soil or sediment ( $\mu\text{g/kg}$ or $\text{mg/kg}$ )
$DFS_{adj}$	=	age-adjusted dermal contact factor [ $(\text{mg-year})/(\text{kg-day})$ ]
$ABS_{dermal}$	=	dermal absorption efficiency (0.13) (unitless)
$SA_a$	=	exposed skin surface area – adult (square centimeters [ $\text{cm}^2$ ])
$SA_c$	=	exposed skin surface area – child ( $\text{cm}^2$ )
$AF_a$	=	soil-to-skin adherence factor – adult ( $\text{mg}/\text{cm}^2$ )
$AF_c$	=	soil-to-skin adherence factor – child ( $\text{mg}/\text{cm}^2$ )
$EF$	=	exposure frequency (days/year)
$ED_a$	=	exposure duration – adult (years)
$ED_c$	=	exposure duration – child (years)
$BW_a$	=	body weight – adult (kg)
$BW_c$	=	body weight –child (kg)
$AT$	=	averaging time (days)
$CSF$	=	cancer slope factor ( $\text{mg}/\text{kg-day}$ ) <sup>-1</sup>
$RfD$	=	reference dose ( $\text{mg}/\text{kg-day}$ )
$THQ$	=	target hazard quotient
$TR$	=	target excess cancer risk

**Commented [BLJ28]:** Can't be both since units on the remainder of the terms are specified? Please check units and resolve inconsistency.

**Commented [BLJ29]:** Inconsistent notation. Should the “dermal” subscript be added to “ABS” in preceding equations or should it be removed here.

I notice that ABS and ABS\_dermal are listed separately in Table 2.

**Commented [BLJ30]:** Is this correct?

Risk-based PRGs for cPAHs based on dermal exposure to sediments were also calculated as using the early-life exposure adjustments described in Section 1.1.3:

$$PRG_{sed} = \frac{TR \times AT}{EF \times CSF \times DSCFM_{adj} \times ABS \times CF}$$

Where:

$$DSCFM_{adj} = \left( \frac{\frac{ED_{0-2} \times AF_c \times SA_c \times 10}{BW_c} + \frac{ED_{2-6} \times AF_c \times SA_c \times 3}{BW_c}}{\frac{ED_{6-16} \times AF_a \times SA_a \times 3}{BW_a} + \frac{(ED_{16-30} \times AF_a \times SA_a \times 1)}{BW_a}} \right)$$

where:

$PRG_{sed}$	=	chemical concentration in soil or sediment ( $\text{mg}/\text{kg}$ )
$ABS_{dermal}$	=	dermal absorption efficiency
$DSCFM_{adj}$	=	dermal sediment contact factor for mutagens ( $\text{mg-yr}/\text{kg-day}$ )
$SA_a$	=	adult exposed skin surface area (square centimeters [ $\text{cm}^2$ ])
$SA_c$	=	child exposed skin surface area ( $\text{cm}^2$ )
$AF_a$	=	adult soil-to-skin adherence factor ( $\text{mg}/\text{cm}^2$ )
$AF_c$	=	child soil-to-skin adherence factor ( $\text{mg}/\text{cm}^2$ )
$EF$	=	exposure frequency (days/year)
$ED_{0-2}$	=	exposure duration ages 0-2 (years)
$ED_{2-6}$	=	exposure duration ages 2-6 (years)
$ED_{6-16}$	=	exposure duration ages 6-16 (years)
$ED_{16-30}$	=	exposure duration ages 16-30 (years)

**Commented [BLJ31]:** Inconsistent notation.

**Formatted:** Subscript

$BW_a$  = adult body weight (kg)  
 $BW_c$  = child body weight (kg)  
 $AT$  = averaging time (days)  
 $TR$  = target excess cancer risk

Formatted: Subscript

Formatted: Subscript

Exposure assumptions are presented in Tables 3-21 and 3-22 of the Final BHHRA.

The individual pathway-specific calculations are combined to a total risk-based PRG in sediment using the following equation:

$$PRG_{sed} = \frac{1}{\frac{1}{Conc_{sed} - Ingestion} + \frac{1}{Conc_{sed} - dermal}}$$

**Commented [BLJ32]:** There should be some text to explain the rationale for using this equation to calculate a "total risk-based PRG" in sediment. If this is a standard EPA approach then provide an appropriate reference.

**Commented [BLJ33]:** The concentration terms in this equation are not defined. Should these be "PRG" values rather than "Conc"?

If the equations were numbered then you could refer back to specific equations in identify the two Conc<sub>sed</sub> terms.

### 1.1.5 Calculation of Sediment Risk-Based PRGs for Fish/Shellfish Consumption

Target tissue concentrations were calculated using the method described in Section 1.1.1. To calculate sediment PRGs for scenarios where fish consumption is primarily the fillet, it was necessary to determine the relationship between whole body and fillet-only concentrations, because both the BSAFs/BSARs and the FWM are based on whole body concentrations. The whole-body ~~concentration~~-to-fillet-fillet-concentration ratios were calculated using the measured mean whole body and fillet concentrations of each COC on a river mile or fishing zone basis, and are presented in Table 4.

**Commented [BLJ34]:** Provide reference that describes the original analysis.

#### cPAHs

The Bioaccumulation Modeling Report (Windward, 2009) presented a calculated BSAR for benzo(a)pyrene in field clams as the following equation:

$$\ln(PRG_{sed}) = \frac{\ln(C_{tissue}) - \ln(CF) + 2.47}{0.60}$$

In order to calculate a PRG, the BSAR for benzo(a)pyrene was considered representative of total carcinogenic PAHs. Because the BSAR is based on lipid-normalized tissue and organic carbon normalized, corrections for site organic carbon and the lipid content of clams were incorporated to arrive at a dry-weight sediment concentration:

$$\ln(PRG_{sed}) = \left[ \frac{(\ln(C_{tissue}) - \ln(f_{lipid})) - \ln(CF) + 2.47}{0.60} \right] + \ln(f_{oc})$$

And:

$$PRG_{sed} = e^{\left[ \frac{(\ln(C_{tissue}) - \ln(f_{lipid})) - \ln(CF) + 2.47}{0.60} \right] + \ln(f_{oc})}$$

$$PRG_{sed} = \exp\left(\left[\frac{\ln(C_{tissue}) - \ln(f_{lipid}) - \ln(CF) + 2.47}{0.60}\right] + \ln(f_{oc})\right)$$

$PRG_{sed}$  = risk-based PRG in sediment (µg/kg)  
 $C_{tissue}$  = risk-based target fish/shellfish tissue concentration – wet weight (µg/kg)  
 $CF$  = correction factor (2.31, see Table 4-1, Windward 2009)  
 $f_{oc}$  = fraction organic carbon site sediments (0.0171)  
 $f_{lipid}$  = fraction of lipid in clam tissue (0.22)

**Commented [BLJ35]:** Modified format to improve legibility.

**Field Code Changed**

**Commented [BLJ36]:** There should be references for these values. Not clear why you've chosen to indicate these values among the many parameter values that remain unspecified.

## Hexachlorobenzene

~~Sediment tissue BSAFs for hexachlorobenzene were developed for large home-range species, no relationship was established for smallmouth bass (Windward, 2009).~~  
Sediment-tissue BSAFs for hexachlorobenzene were developed by Windward (2009) for large home-range species. No relationship between sediment and tissue concentrations was established for smallmouth bass. The general relationship between sediment and tissue concentrations is expressed by the following equation:

$$PRG_{sed} = \frac{C_{tissue}}{BSAF}$$

$$PRG_{sed} = \frac{PRG_{tissue}}{BSAF}$$

**Commented [BLJ37]:** Original language was grammatically incorrect and difficult to read. Please check that original meaning not changed.

**Commented [BLJ38]:** Should  $C_{tissue}$  in this case be  $PRG_{tissue}$

**Field Code Changed**

The calculation of  $PRG_{tissue}$  is described in Sections 1.1.1 and 1.1.2 of this Appendix.

**Formatted:** Font: Times New Roman, 12 pt, Subscript

Correcting for the organic carbon content of sediment and lipid content of fish gives the following equation:

$$PRG_{sed} = \frac{\left[\left(\frac{C_{tissue}}{f_{lipid}}\right) \times f_{oc}\right]}{BSAF}$$

where:

$PRG_{sed}$  = concentration in sediment (µg/kg)  
 $f_{lipid}$  = lipid content of fish (percent)  
 $f_{oc}$  = sediment organic carbon content (0.0171)  
 $BSAF$  = biota-sediment accumulation factor (unitless)

**Commented [BLJ39]:** If the fish lipid content is given in percent and the sediment organic carbon content is expressed as a fraction then it would seem that units have been mixed incorrectly. Please check the definition and check calculations if this is found to be necessary.



	BSAF	Fish Lipid Content (percent)
Black Crappie	2.02	5.2
Brown Bullhead	0.295	2.4
Carp	0.244	8.8

**Commented [BLJ40]:** Needs table number and reference describing source of information.

As noted above, BSAFs were only developed for large home-range species, and not for smallmouth bass. Accordingly, target sediment concentrations were calculated for each species, and the risk-based sediment PRG for hexachlorobenzene was calculated using the following equation:

$$PRG_{sed} = \frac{1}{\frac{1}{Conc_{sed} - Crappie} + \frac{1}{Conc_{sed} - Carp} + \frac{1}{Conc_{sed} - Bullhead}}$$

**Commented [BLJ41]:** Should these "Conc" terms be referred to as "PRG"? As noted above, there should be an explanation for combining the individual PRG values using this approach.

#### PRGs calculated using the Food-Web Model (FWM)

The Arnot and Gobas food-web model (Windward, 2009) was refined for Portland Harbor, and. The model accounts for uptake of contaminants via direct incidental ingestion, dietary uptake, and uptake of dissolved contaminants via ingestion and gill uptake. The FWM was calibrated for chlorinated persistent organic contaminants (aldrin, dieldrin, chlordane, DDx, PCBs, and dioxins/furans). Although the final BHHRA evaluated consumption of smallmouth bass, carp, brown bullhead, and crappie, the latter two species are not evaluated in the FWM. However, largescale sucker were used as a surrogate for bullhead, and sculpin as a surrogate for crappie, as they were considered representative of the same trophic group (Windward, 2009). In addition, the FWM as calibrated for 2,3,4,7,8-pentachlorodibenzo furan was assumed to be representative of total dioxins/furans. Oregon human health ambient water quality criteria for consumption of water and organism were used as input for dissolved water concentration (DEQ, 2011).

**Commented [BLJ42]:** Is there a simple way of summarizing the results of the Food-Web model? Would the output be in a form similar to the BASF and BASR terms? If so could these go in a table? This would go a long way towards improving the transparency of the procedure as readers could do calculations of PRGs themselves and compare to the reported values.

**Commented [BLJ43]:** Original language unclear.

The calculated whole fish body concentrations-PRG values were converted to fillet concentrations-PRGs using the measured (insert reference here) ratios of whole-body contaminant concentration to fillet contaminant concentration/fillet ratios as presented in Table 4. The resulting fillet concentration for each of the four species were was further combined as a weighted mean, with each species representing 25 percent of the total diet. The goal-seek function in Excel was then used to iteratively calculate an average sediment concentration-PRG concentration that resulted in the averaged tissue concentration-PRG of the four modeled species.

**Formatted:** Font: Times New Roman, 12 pt, Italic

**Commented [BLJ44]:** Original language lacked clarity. Please check that this is correct and include reference.

**Commented [BLJ45]:** Maybe you should list the four species. It's difficult to determine based on the discussion.

## 1.1.6 REFERENCES

Kennedy/Jenks Consultants. 2013. Portland Harbor RI/FS, Final Remedial Investigation Report, Appendix F, Baseline Human Health Risk Assessment. Portland, OR. April 2013.

Oregon Department of Environmental Quality (ODEQ), 2011. Water Quality Standards for Toxic Pollutants, Table 40. OAR 340-041-0033

Windward. 2009. Portland Harbor RI/FS Bioaccumulation Modeling Report. Draft. WE-09-0003. Prepared for the Lower Willamette Group, Portland, OR. Windward Environmental LLC, Seattle, WA. July 21, 2009.

Formatted: Keep with next

Table 1  
Risk-Based Preliminary Remediation Goals In Fish Tissue

	PRGs (µg/kg fish tissue) Consumption Rate = 142 g/day				
	Cancer	Noncancer	Infant	PRG	Basis <sup>a</sup>
Arsenic	6.7.E-01	7.9.E+01		6.7.E-01	ca
Aldrin	5.9.E-02	7.9.E+00		5.9.E-02	ca
Dieldrin	6.3.E-02	1.3.E+01		6.3.E-02	ca
Chlordane	2.9.E+00	1.3.E+02		2.9.E+00	ca
DDx	3.0.E+00	1.3.E+02	9.4E+01	3.0.E+00	ca
Hexachlorobenzene	6.3.E-01	2.1.E+02		6.3.E-01	ca
cPAHs	4.6.E-02	7.9.E+01			ca
PCBs	5.0.E-01	5.2.E+00	2.7E-01	2.7.E-01	infant
TCDD	7.7.E-06	1.8.E-04	6.2E-06	6.2.E-06	infant
PDBEs		2.6.E+01	8.9E-01	8.9.E-01	infant

a – ca = cancer endpoint, infant = infant consumption of breastmilk

Table 2: Specific Exposure Values

Symbol	Description	Subsistence Fisher	Tribal Fisher	Recreational Beach Use	Dockside Worker	In-Water Worker	Infant Consumption of Breast milk
ABS <sub>dermal</sub>	absorption efficiency	See Table 3	See Table 3	See Table 3	See Table 3	See Table 3	--
ABS	absorption efficiency (mg-yr/kg-day)	See Table 3	See Table 3	See Table 3	See Table 3	See Table 3	--
AE	oral absorption efficiency of the chemical	--	--	--	--	--	1
AF <sub>a</sub>	soil-to-skin adherence factor – adult (mg/cm <sup>2</sup> )	0.3	0.3	0.3	0.2	0.2	--
AF <sub>c</sub>	soil-to-skin adherence factor – child (mg/cm <sup>2</sup> )	--	--	3.3	--	--	--
AT <sub>c</sub>	averaging time – carcinogenic exposures (days)	25,550	25,550	25,550	25,550	25,550	--
AT <sub>inf</sub>	averaging time – infant exposure (days)	--	--	--	--	--	365
AT <sub>m</sub>	averaging time – maternal exposure (days)	--	--	--	--	--	--
BW <sub>a</sub>	body weight – adult (kg)	70	--	70	70	70	70
BW <sub>a</sub>	body weight – adult (maternal body weight, kg)	--	--	--	--	--	--
BW <sub>c</sub>	body weight – child (kg)	15	--	15	--	--	--
BW <sub>inf</sub>	average infant body weight (kg)	--	--	--	--	--	7.8
CR	maternal consumption rate of fish (g/day)	--	--	--	--	--	142
CR <sub>a</sub>	consumption rate of fish/shellfish – adult (g/day, wet-weight)	142/3.3	--	--	--	--	--
CR <sub>c</sub>	consumption rate of fish/shellfish – child (g/day, wet-weight)	60/--	--	--	--	--	--
CR <sub>milk</sub>	infant consumption rate of breast milk (kg/day)	--	--	--	--	--	0.98
CSF	cancer slope factor (mg/kg-day) <sup>-1</sup>	See Table 3	See Table 3	See Table 3	See Table 3	See Table 3	--
ED <sub>0-2</sub>	exposure duration ages 0-2 (years)	--	--	2	--	--	--
ED <sub>16-30</sub>	exposure duration ages 16-30 (years)	--	--	14	--	--	--
ED <sub>2-6</sub>	exposure duration ages 2-6 (years)	--	--	4	--	--	--
ED <sub>6-16</sub>	exposure duration ages 6-16 (years)	--	--	10	--	--	--
ED <sub>a</sub>	exposure duration – adult (years)	30	70	30	25	10	--
ED <sub>c</sub>	exposure duration – child (years)	6	--	6	--	--	--
ED <sub>inf</sub>	exposure duration of breastfeeding infant (days)	--	--	--	--	--	365
EF	exposure frequency (days/year)	350/156 <sup>a</sup>	260	94	50	10	--
EF <sub>a</sub>	exposure frequency – adult (maternal exposure, days/yr)	--	--	--	--	--	350
f <sub>f</sub>	fraction of absorbed chemical stored in fat	--	--	--	--	--	0.9
f <sub>fm</sub>	fraction of mother's weight that is fat	--	--	--	--	--	0.3
f <sub>mbm</sub>	fraction of fat in breast milk	--	--	--	--	--	0.04
h	biological half-life of chemical in the body (days)	--	--	--	--	--	See Table 3
IRS <sub>a</sub>	incidental sediment ingestion rate-adults (mg/day)	100	100	100	--	200	--
IRS <sub>c</sub>	incidental sediment ingestion rate-children (mg/day)	--	--	200	--	--	--
RfD	reference dose (mg/kg-day)	--	--	--	--	--	--
SA <sub>a</sub>	exposed skin surface area – adult (cm <sup>2</sup> )	1,980/5,700 <sup>b</sup>	1,980/5,700	5,700	3,300	3,300	--
SA <sub>c</sub>	exposed skin surface area – child (cm <sup>2</sup> )	--	--	2,800	--	--	--
THQ	target hazard quotient	1	1	1	1	1	1
TR	target excess cancer risk	1 x 10 <sup>-6</sup>	1 x 10 <sup>-6</sup>	1 x 10 <sup>-6</sup>	1 x 10 <sup>-6</sup>	1 x 10 <sup>-6</sup>	--

Commented [BLJ46]: Is this the same as ABS<sub>dermal</sub>?

Commented [BLJ47]: Are the units specified here correct?

Commented [BLJ48]: No value specified for maternal exposure averaging time.

Commented [BLJ49]: No value specified for maternal body weight.

Commented [BLJ50]: Reference dose does not belong in table since it is chemical-specific.

a – 350 days/year fish consumption and 156 days./year sediment contact while fishing

b – beach/in-water sediment

Table 3: Chemical-Specific Values

Chemical	SF (mg/kg-day) <sup>-1</sup>	RfD (mg/kg-day)	Infant RfD (mg/kg-day)	h (days)	ABS
Antimony		4.0E-03			
Arsenic	1.5E+00	3.0E-04			0.03
Mercury		1.0E-04			
cPAHs	7.3E+00	3.0E-04			0.13
Bis(2-ethylhexyl)phthalate	1.4E-02	2.0E-02	2.0E-02		0.1
Aldrin	1.7E+01	3.0E-05			0.1
Dieldrin	1.6E+01	5.0E-05	5.0E-05		0.1
Chlordane	3.5E-01	5.0E-04	5.0E-04		0.04
DDx	3.4E-01	5.0E-04	5.0E-04	120	0.03
Hexachlorobenzene	1.6E+00	8.0E-04			0.1
Pentachlorophenol	4.0E-01	5.0E-03			0.25
PCBs	2.0E+00	2.0E-05	3.0E-05	2555	0.14
PDBEs		1.0E-04	1.0E-04	2555	0.14
2,3,7,8-TCDD	1.3E+05	7.0E-10	7.0E-10	2550	0.03

Commented [BLJ51]: What are units?

Table 4  
Whole Body/Fillet Contaminant Concentration Ratios

	Smallmouth Bass	Carp	Black Crappie	Brown Bullhead
Aldrin <sup>a</sup>	5.77	1.36	12	10.46
Chlordane	5.92	1.4	12	10.46
Dieldrin	5.77	1.36	12 <sup>b</sup>	10.46 <sup>b</sup>
DDx <sup>c</sup>	7.17	1.42	6.32	4.06
PCBs	8.02	1.82	5.46	1.56
Total Dioxins/Furans	6.13	1.52	6.13	1.52

a – not measured, based on dieldrin  
b – not measured, based on chlordane  
c – average of DDD, DDE, and DDT

Table 4  
Risk-Based Preliminary Remediation Goals in Tissue

PRGs (µg/kg fish tissue) Consumption Rate = 142 g/day						
-	Cancer	Noncancer	-	Infant	PRG	Basis <sup>a</sup>
Arsenic	6.7.E-01	7.9.E+01	6.7.E-01		6.7.E-01	ea
Aldrin	5.9.E-02	7.9.E+00	5.9.E-02		5.9.E-02	ea
Dieldrin	6.3.E-02	1.3.E+01	6.3.E-02		6.3.E-02	ea
Chlordane	2.9.E+00	1.3.E+02	2.9.E+00		2.9.E+00	ea
DDx	3.0.E+00	1.3.E+02	3.0.E+00	9.4E+01	3.0.E+00	ea
Hexachlorobenzene	6.3.E-01	2.1.E+02	6.3.E-01		6.3.E-01	ea
ePAHs	4.6.E-02	7.9.E+01	4.6.E-02			ea
PCBs	5.0.E-01	5.2.E+00	5.0.E-01	2.7E-01	2.7.E-01	infant
TCDD	7.7.E-06	1.8.E-04	7.7.E-06	6.2E-06	6.2.E-06	infant
PDBEs		2.6.E+01	2.6.E+01	8.9E-01	8.9.E-01	infant

Commented [BLJ52]: Duplicate table